A synthetic perturbative hypothesis for multiscale analysis of bluff-body wake instability

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A nonparallel stability analysis of the intermediate region of the two-dimensional wake behind a bluff body is performed using a WKBJ method on a basic flow previously derived from intermediate asymptotics[1]. The multiscaling is carried out to explicitly account for the effects associated to the lateral momentum dynamics. These features of the base flow can be included in the perturbative equation as well as in the associate modulation equation through a spatial multiscaling[2] or, more generally, through a spatio-temporal multiscaling[3]. At the first order, the disturbance is locally tuned to the property of the instability, as can be seen by the zero order theory. This leads to a very synthetic analysis of the nonparallel correction on the instability characteristics. The system is perturbed by disturbances with a wave number that varies along the wake and which is locally equal to the wave number of the dominant saddle point of the zero order dispersion relation, taken at different Reynolds numbers. In this way, the Reynolds number is the only parameter, in contrast with the more classical parametrization with respect to both the wave number and the Reynolds number[3]. It is shown that the corrections to the frequency, temporal and spatial growth rate are remarkable in the first part of the intermediate wake and lead to absolute instability in regions that extend to 10 body scales, see Fig.1a. The correction increases with the Reynolds number and agrees with data from laboratory and numerical experiments in literature, see Fig.1b.

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[3]Belan and Tordella, *J. Fluid Mech.*, revised (December 2005).

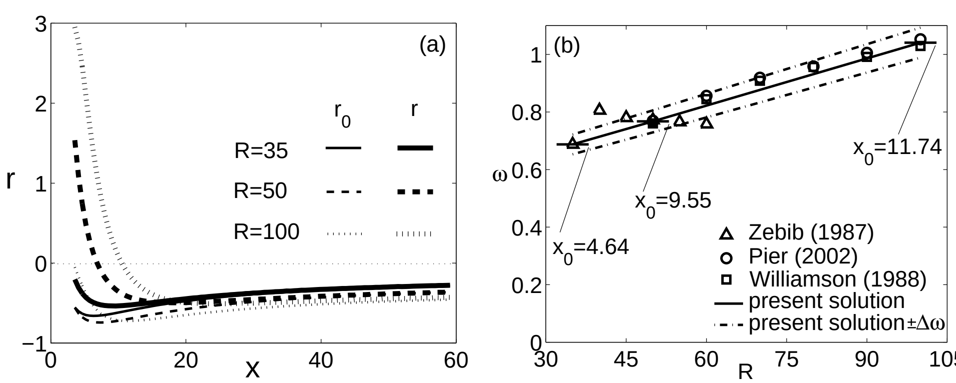

Figure 1: (a) Temporal growth rate 0-order (r_0) and (0+1)-order (r), R = 35, 50, 100; (b) Pulsation: present solution ($\Delta\omega = 0.05$) and global results in literature.